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Factors affecting students' concept retention in learning science online using instructional videos

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ABSTRACT

Effective science instruction in a blended learning approach is synonymous with the strategic use of instructional videos (IVs) to fill the gap in teacher support. This study aims to determine the IVs' effectiveness in improving students' concept retention and overall learning experiences. The experimental group was exposed to instruction integrating IVs via embedded mixed-method design, whereas the control group was exposed to traditional lecture methods. The results showed that students' post-test scores and concept retention improved significantly in the experimental group, where students reported better learning experiences than in the control group. This beneficial effect of a technology-integrated approach can be attributed to various elements of IVs, such as engaging content, motion graphics, video length, the language used, and the speaker's perspective. This study recommends that IVs be used to enhance learning opportunities and results in the teaching and learning process.

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1. INTRODUCTION

Advancements in technology have led to a wide range of new instructional media that can be used in education. For example, the widespread availability of the Internet and mobile devices has led to the development of online and mobile learning resources, such as videos, podcasts, and interactive simulations [1]–[3]. Instructional videos (IVs) have been part of the educational process, supporting varied, flexible teaching and learning modalities around the globe [4]. Purported to impact students' holistic development and retention, IVs help learning be more efficient, interactive, and meaningful to students [5]. At a certain point in educational advancements, the influence of instructional media assisted in evaluating students' ability to learn effectively and collaboratively [6], [7]. Students are exposed to a learning experience comprised of good sensory experience-coordination, stimulation, and engagement. These educational materials increase of knowledge retention, information processing skills, and increase learning motivation [8], [9].

Likewise, the IVs material has been known to assist teachers in their pedagogical strategies. Research has shown that IVs can increase teacher effectiveness by allowing them to present information in a visual and auditory format, engage students more effectively, and provide new ways to assess student learning and progress [10]. IVs can also help teachers differentiate instruction and provide personalized learning experiences for students [11], [12]. IVs can also help teachers save time, providing students with independent learning opportunities allowing teachers to focus on other areas of instruction or to work with small groups of students [13], [14].

Despite the benefits of using IVs to cater to students' needs, their retentions are put into tests every quarter, leaving queries of how effective IVs are to the learners' end in understanding science concepts. According to Mayer and Moreno [9], the complexity of the content should be considered as its implications may be more or less likely to contribute to students' academic achievement. With the physical absence of instructors in students' learning process, they experienced barriers in learning as facilitation nedds to be attended to, leading to confusion and misconception of science concepts. Video length also influences the students' decision-making, whether to watch the video or not, supporting a study by Ali [15], wherein students quickly get bored watching IVs. In a local context, Rosales [16] implied the effectiveness of subtitled video materials due to their benefits. However, it still needs to be recognized by the teachers, leaving students confused about the terms used in the videos and unable to research the jargon. To address the research gaps mentioned, scrutinizing IVs should be considered. Therefore, to uphold effective learning, factors of the IVs are identified to recognize the gaps teachers struggle with in delivering their lessons that affect the students' retention of science concepts. Specifically, this study aims to answer the following questions, to wit:

- What is the level of students' retention in learning science in the control group (without IVs) and experimental group (with IVs)?
- Is there a significant difference in the level of concept retention between the experimental and control groups?
- What factors of IVs affect the students' concept retention?
- To what extent do these factors of IVs affect the students' concept retention?
- What are the student's learning experiences in integrating IVs into their science online class?

2. RESEARCH METHOD

2.1. Research design

This study utilized an embedded mixed methods design, combining quasi-experimental and semi-structured interviews. This research design combines qualitative and quantitative techniques, approaches, concepts, methods, and language for a comprehensive understanding and validation [17]. The researchers measured concept retention in students who watched IVs versus those who did not use a quasi-experimental design with a pretest and posttest. A Likert scale survey was used to identify the elements of IVs and their effects on retention. After watching the videos, participants' learning experiences were evaluated using a one-on-one interview method, which helped to pinpoint their main points of view and experiences.

2.2. Locale and respondents

This study was conducted in a private school in Consolacion, Cebu, Philippines, where data was collected using Google Forms from Grade 8 Science subjects. Due to COVID-19 restrictions, the study was conducted online with the cooperating teacher. The participants were divided into two groups of at least 26 students each. One group was exposed to science IVs, while the other was the control group. The researchers used purposive sampling to select potential participants based on specific criteria [18], including i) selecting two classes with the same number of students, ii) two classes under the supervision of one science teacher, and iii) students taking up a science subject. Prior to data collection, ethical considerations regarding human participants were addressed to ensure a proper research process. Consent letters were distributed online, and participants were assured of their safety and protection. The collected data was analyzed to maintain objectivity and eliminate biases. The study followed strict research ethics protocols approved by the CNU-Research Ethics Committee (1229/2022-03 Buayaban).

2.3. Instruments

2.3.1. Detailed lesson plan

Lesson plans for 8th-grade Biology were developed by researchers, with four lessons covering reproductive system parts and functions, hormone roles, feedback mechanisms, and nervous system coordination. These plans were modified in collaboration with the cooperating in-service teacher. The lesson

plans were used for both control and experimental groups, with the experimental group receiving additional intervention variables.

2.3.2. Pretest and posttest questionnaire

The study used researcher-made questionnaires to measure pre- and post-knowledge of the nervous and reproductive systems. The pretest questionnaire had 20 multiple-choice questions, while the posttest had 20 questions to measure how well students remembered the topic. The questionnaires were distributed using Google Forms through Google Classroom. A pilot test was conducted before the actual study with 20 students [19]. The Kuder-Richardson 20 was used in this test to assess the reliability of the pre-posttest questionnaire. The findings revealed a moderate correlation with a value of 0.6, implying that the questionnaire is valid.

2.3.3. Survey questionnaire

The questionnaire includes a Likert scale and open-ended questions to evaluate the impact of IVs on students' concept retention. The Likert scale contains statements about video content, motion graphics, language, subtitles, speaker perspective, and video length. The open-ended questions aim to gather students' positive and negative experiences, particularly those in the experimental group taught using IVs. Cronbach's alpha reliability test was used to measure the Likert scale and open-ended questions. The result obtained was 0.7, indicating that the instruments are acceptable and reliable for the study.

2.4. Instructional design

The 7Es (elicit, engage, explore, explain, elaborate and evaluate and extend) lesson plan model was used for the intervention's instructional design [20]. Prior knowledge was extracted from students using guessing game activities and process questions (elicit phase). Critical thinking skills were promoted through open-ended questions, debates, sequencing order, and mnemonics activities (engage phase). Then, the students were encouraged to interpret observations from simulations and matching activities to deepen their understanding (explore phase). Furthermore, the study compared the effects of science IVs on students' concept retention between experimental and control groups. The experimental group was shown IVs facilitated by the cooperating teacher, while the control group received conventional instruction through PowerPoint presentations and virtual discussions (explain phase). Sequentially, students in both groups were given specific questions to answer, followed by process questions for idea extension (elaborate phase). The concluding activity involved formal and informal assessments, including oral recitations, multiple choice and true or false questions, and work submission through Google Classroom and other online platforms (evaluate phase). Lastly, students were required to complete the homework, aiding in concept retention and application to new situations (extend phase).

2.5. Data analysis

The data obtained from the implementation was saved in a spreadsheet. Normality tests were conducted to determine the statistical test to be used due to a small sample size. As shown in Table 1, data are normally distributed in terms of kurtosis and skewness. For Shapiro-Wilk values, the data are approximately normally distributed since most of the p-values are above 0.05, keeping the null hypothesis.

Table 1. Normality tests of participants' pretest, posttest, and delayed test scores

Groups	n	$\bar{x}$	SD	Kolmogorov-Smirnov		Shapiro-Wilk		Skewness	Kurtosis
				Test statistic	P-value*	Test statistic	P-value*		
Control Group RS pretest	24	4.96	1.654	0.198	0.266	0.929	0.095	0.386	-0.296
Experimental Group RS pretest	24	5.13	1.963	0.151	0.593	0.965	0.549	0.073	-0.093
Control Group RS posttest	24	6.04	2.074	0.182	0.363	0.935	0.129	-0.666	0.332
Experimental Group RS posttest	24	6.63	1.583	0.188	0.325	0.919	0.057	-0.035	-1.208
Control Group NS pretest	24	4.13	1.513	0.159	0.530	0.921	0.060	0.757	0.668
Experimental Group NS pretest	24	4.00	1.251	0.293	0.026	0.769	0.000	1.163	0.714
Control Group NS posttest	24	5.46	1.978	0.178	0.394	0.955	0.344	-0.190	-0.374
Experimental Group NS posttest	24	6.04	1.488	0.197	0.272	0.912	0.039	-0.595	-0.291
Control Group delayed test	24	13.38	3.965	0.126	0.799	0.943	0.186	-0.431	-0.662
Experimental Group delayed test	24	13.33	2.565	0.239	0.109	0.855	0.003	-1.687	3.938

Note. RS – Reproductive System; NS – Nervous System

The pretest, post-test, and delayed test (content retention test) scores were analyzed using mean and standard deviation for descriptive statistics. The t-test for dependent samples was used to compare the means of two sets of scores directly related to each other in comparing pretest-posttest scores and posttest-delayed test scores. Meanwhile, descriptive analysis summarizes the findings to answer how much the IVs factors influence respondents' concept retention. Statistical analysis and treatment were done using the software statistical packages for social sciences (SPSS) 26. In the qualitative phase, the results of the open-ended question questionnaire are analyzed and scrutinized by Braun and Clarke [21] using reflexive thematic analysis to assess each participant's learning experiences.

3. RESULTS AND DISCUSSION

3.1. Test scores of the participants

This section shows the students' test scores in the pretest, post-test, and delayed test, as shown in Table 2. The control group had below-average pretest scores in reproductive and nervous system concepts. Meanwhile, the experimental group had an average pretest score in the reproductive system concept but had below-average pretest scores in the nervous system concept. Overall, both groups had below-average pretest scores for the two concepts. Individual differences can contribute to variations in pretest scores, with some students naturally performing below average due to diverse backgrounds, abilities, and prior knowledge [22].

Table 2. Respondents' pretest, posttest, and delayed test scores

Group	Topic	Pretest			Post-test			Delayed test		
		Mean	SD	Description	Mean	SD	Description	Mean	SD	Description
Control	Reproductive system	4.96	1.65	Below average	6.04	2.07	Average	6.71	2.01	Average
	Nervous system	4.13	1.51	Below average	5.46	1.98	Average	6.67	2.01	Average
	Overall	9.09	3.16	Below average	11.50	4.05	Average	13.38	4.02	Average
Experimental	Reproductive system	5.13	1.96	Average	6.63	1.58	Average	6.92	1.02	Average
	Nervous system	4.00	1.25	Below average	6.04	1.49	Average	6.83	1.01	Average
	Overall	9.13	3.21	Below average	12.67	3.07	Average	13.75	2.03	Average

Both groups had average post-test scores for the two concepts. However, the experimental group gained higher per-concept and overall post-test scores than the control group. A delayed test was also administered to evaluate students' retention, revealing that the experimental group had higher per-concept and overall delayed test scores.

Table 3 shows the difference in pretest and post-test scores between both groups. It can be noted that both groups gained higher post-test scores from the pretest scores. The experimental group consistently had a higher difference score for reproductive system and nervous system concepts as compared to the control group.

Table 3. Comparison between the respondents' pretest and the posttest scores

Group	Topic	Mean			SD	t-value	p-value
		Pretest	Post-test	Difference			
Control	Reproductive system	4.96	6.04	1.08	1.95	2.716	0.012
	Nervous system	4.13	5.46	1.33	1.49	4.372	0.000
	Overall	9.09	11.5	2.41	1.72	4.852	0.000
Experimental	Reproductive system	5.13	6.63	1.50	2.54	2.897	0.008
	Nervous system	4.00	6.04	2.04	2.33	4.291	0.000
	Overall	9.13	12.67	3.54	2.42	5.058	0.000

Moreover, test statistics revealed that both groups had significant medium differences for the reproductive system, while a significant difference was observed for the nervous system concept. Since a significant difference was observed in both groups' pretest and post-test scores, as shown in Table 4, the null hypothesis is rejected, indicating that the instruction for the control group and the intervention for the experimental group were all effective.

The content retention of both groups is very high for the two concepts. However, a higher retention percentage is observed in the control group, as shown in Table 5. Furthermore, test statistics revealed a significant medium difference in students' concept retention for both groups. However, there is no significant difference in their retention of the reproductive system concept, as shown in Tables 6 and 7.

Table 4. Difference between the pretest and posttest scores of the two groups

Group	Topic	Test Statistic	p-value*	Description	Remarks
Experimental	Reproductive system	2.897	0.008	Significant medium difference	Reject null hypothesis
Group	Nervous system	4.291	0.000	Significant large difference	Reject null hypothesis
Control	Reproductive system	2.716	0.012	Significant medium difference	Reject null hypothesis
Group	Nervous system	4.372	0.000	Significant large difference	Reject null hypothesis

Note. H_{01}: There is no significant difference between the pretest and post-test scores of the respondents; *significance value=0.05

Table 5. Percent content retention of the respondents

Group	Topic	Mean		Difference	% Retention	Description
		Posttest	Delayed test			
Control	Reproductive system	6.04	6.71	0.67	>100	Very high
	Nervous system	5.46	6.67	1.21	>100	Very high
	Overall	11.50	13.38	1.88	>100	Very high
Experimental	Reproductive system	6.63	6.92	0.29	>100	Very high
	Nervous system	6.04	6.83	0.79	>100	Very high
	Overall	12.67	13.75	1.08	>100	Very high

Table 6. Difference between the post-test and delayed test scores of the two groups

Group	Topic	Test Statistic	p-value*	Description	Remarks
Experimental	Reproductive system	0.892	0.381	No significant difference	Accept null hypothesis
Group	Nervous system	2.632	0.015	Significant medium difference	Reject null hypothesis
Control	Reproductive system	1.515	0.143	No significant difference	Accept null hypothesis
Group	Nervous system	3.136	0.005	Significant medium difference	Reject null hypothesis

Note. H_{02}: there is no significant difference between the posttest and delayed test scores of the respondents; *significance value=0.05

Table 7. Comparison of mean gain of students' concept retention

Topic	Group	Mean gain	SD	t-value	p-value*	Remarks
Reproductive system	Control group	0.67	1.95	-0.649	.520	Not significant
	Experimental group	0.29	1.02			
Nervous system	Control group	1.21	2.01	-0.363	.719	Not significant
	Experimental group	0.79	1.00			

Note. H_{03}: there is no significant difference between the posttest and delayed test scores of the respondents; *significance value=0.05

The IVs support students' learning progress across various subjects, particularly in science. They effectively address learners' challenges by assisting them in overcoming barriers to understanding topics across all subject areas [23], mainly when educational institutions increasingly rely on online learning. Ensuring student retention is crucial for success in higher education. Shieh and Yu [24] defined learning retention as retaining memories after learning. The study found no significant difference between the mean gain scores of experimental and control groups. However, this does not imply that independent variables do not positively affect concept retention and overall learning experiences. The study considered factors such as COVID-19's effects on the online learning environment, unstable internet connections, and distractions at home, which may have contributed to the lack of change in test scores determining concept retention. As claimed by Geri [25], investigating the impact of videos on students' retention in distance learning reveals how educational videos positively impact increasing students' retention. Similarly, the study conducted by Duverger and Steffes [26] reported that videos increase students' retention significantly as long as the video is congruent with the instructional materials of the lesson.

3.2. Perceptions towards the use of instructional videos

IVs contribute to the students' learning progress in different subjects, especially in science. YouTube videos effectively deal with the learners' difficulties, helping them overcome barriers to understanding topics of every subject [23], especially during this pandemic wherein educational institutions lean on online learning. The factors of the videos include the content, motion graphics, language and presence of subtitles, perspective or the speaker's persona, and length. These factors affect the concept retention of the students.

Learning content is a broad definition of facts, themes, behaviors, beliefs, concepts, and topics often classified within each subject or learning area under knowledge, values, attitudes, and skills anticipated to be learned, forming the basis of teaching and learning. The content of IVs should appear adequate to the understanding of the learners. Content takes part in the students' retention, as the cognitive load needs to be considered to ensure the effectiveness of IVs [9].

Table 8 summarizes the content of IVs that positively affects students' concept retention. It gathered that 6.9% firmly agree, with a mean of 4.76 and a standard deviation of 0.42, which means that the video is

highly related to their topic. On the other hand, with a mean of 4.69 and 0.54 standard deviation, 73.1% of the students agreed strongly on how the content of IVs effectively helps emphasize essential concepts of the Science lesson. Furthermore, with a mean of 4.46 and a standard deviation of 0.70, 57.7% of students strongly agree that videos further explained the processes and function of the body system per learning competency. Furthermore, 65.4%, with a mean of 1.5 and 0.90 standard deviations, strongly disagree that the IVs did not contribute to their understanding of the lesson. In the study of Mayer and Moreno [9], content takes part in the students' retention, as the cognitive load needs to be considered to ensure the effectiveness of IVs. As well as its complexity, one should be aware of the concept of combining visual and auditory channels as its implications may be more or less likely to contribute to students' academic achievement, which implies that teachers should scout effective, readily available IVs online for integration in the teaching and learning process.

Table 8. Participants' perception of the content of the videos used in the intervention

Statements	Level of agreement (%)					Mean	SD	Interpretation
	1	2	3	4	5			
The videos presented are highly related to the topic.	0	0	0	23.10	76.90	4.76	0.42	Strongly agree
The videos effectively help in emphasizing the important concepts of the lesson.	0	0	3.80	23.10	73.10	4.69	0.54	Strongly agree
The videos further explained the processes and functions of the body systems discussed.	0	0	11.5	30.80	57.70	4.46	0.70	Strongly agree
The videos did not help me understand the lesson.	65.40	26.90	3.80	0	3.80	1.5	0.90	Strongly disagree
The content of the videos is too broad for the topic.	38.50	34.60	23.10	0	3.80	1.96	0.71	Disagree

Note. level of agreement: strongly disagree (1.00-1.80); disagree (1.81-2.60); neither agree nor disagree (2.61-3.40); agree (3.41-4.20); and strongly agree (4.21-5.00)

Motion graphics is a type of animation that uses text as a significant component. According to a study by Hanif [27], the use of motion graphic video media substantially impacts students' concept retention. Motion graphics of the video affect students' concept retention. As shown in Table 9, 46.2% of students strongly agree that the presentation style of the footage sustains their focus throughout, where it is supported by a mean of 4.23, and the graphics of the video created a more engaging sensory experience strongly agreed by 57.7% of the participants. Moreover, 58.5% of students shared the same perspectives, strongly agreeing that the graphics presented the lesson content in a structured and sequenced manner, with a mean of 4.58. Additionally, the colors and effects used caught the student's attention. The graphical elements, such as images and graphs, animations, and the entire part of motion graphics, contributed to the students' interest and motivation to learn the lesson.

The results imply that the interactive feature of the motion graphic meets the students' need for an active learning situation. Integrating IVs and the student-centered method in their classroom makes creating a dynamic learning setting easier. Thus, the use of motion graphics in the video significantly affected students' cognitive achievement [27]. Moreover, having a more active learning setup, special features in the video are recommended to be present in the presentation to create a more dynamic learning experience for students.

Table 9. Participants' perception of the motion graphics of the videos used in the intervention

Statements	Level of agreement (%)					Mean	SD	Interpretation
	1	2	3	4	5			
The presentation style of the video makes me focus all throughout.	0	0	15.4%	46.2	38.5	4.23	0.71	Strongly agree
The graphics of the video create a more engaging sensory experience in understanding our lesson.	0	0	11.5%	30.8	57.7	4.46	0.70	Strongly agree
The graphics present the lesson content in a structured and sequenced order.	0	0	11.5%	38.5	50.0	4.38	0.69	Strongly agree
The colors and effects used in the videos draw my attention.	3.8	7.7	23.1%	15.4	50.0	4.00	1.20	Agree
The graphic elements such as the images and graphs make the lesson more interesting to learn.	7.7	0	19.2%	19.2	53.8	4.11	1.21	Agree

Note. level of agreement: strongly disagree (1.00-1.80); disagree (1.81-2.60); neither agree nor disagree (2.61-3.40); agree (3.41-4.20); and strongly agree (4.21-5.00)

Furthermore, Table 10 shows that about 80.8% of the students, with a mean of 4.76, strongly agree that using the English language in the video helps them understand what the speaker is saying. On the other hand, participants disagree with how they cannot understand nor hear the speakers' words in some parts of the video, ranging to 38.5%, underpinned by a mean of 2.46 and a standard deviation of 1.24. More than half of the students said that the slang/jargon words and the absence of subtitles did not affect how they understood the speaker's comments in the video. Unexpectedly, 34.8% neither agree nor disagree if they would understand better if subtitles were integrated into the video.

Table 10. Participants' perception of language and the presence of subtitles on the videos

Statements	Level of agreement (%)					Mean	SD	Interpretation
	1	2	3	4	5			
The use of English as language in the video helps me understand what the speaker is saying.	0	0	3.8	15.4	80.8	4.76	0.51	Strongly agree
Sometimes I could not hear or understand what the speaker was saying.	23.1	38.5	15.4	15.4	7.7	2.46	1.24	Disagree
The speaker was so slang that I could not understand him/her sometimes.	38.5	38.5	19.2	3.8	0	1.88	0.86	Disagree
I did not catch up with the video discussion because there were no subtitles.	19.2	46.2	15.4	19.2	0	2.34	1.01	Disagree
I could have understood the topic of the video better if there were subtitles.	3.8	30.8	34.8	23.1	7.7	3.00	1.01	Neither agree Nor disagree

Note. level of agreement: strongly disagree (1.00-1.80); disagree (1.81-2.60); neither agree nor disagree (2.61-3.40); agree (3.41-4.20); and strongly agree (4.21-5.00)

Overall, the findings imply that the use of the English language positively impacts the students' comprehension of the topic. In the study of Woottipong [28], students agreed that videos were beneficial in learning the course and that English subtitles in video movies were an excellent aid to learning English. However, the presence and absence of subtitles do not impact the students' understanding of the topic, so students understand the video well, depending on the speakers' language and pacing. The speaker's perspective or persona, including their gaze, body orientation, slow-paced or mid-speed speaking, are significant indicators of an instructor's intentional focus in a classroom environment. However, these factors still need to be well known of how they could influence the learners' performance in watching IVs [29].

Table 11 shows that 46.2% of the participants agree that the video is more engaging due to the interest in the speakers' way of talking, supported by a 3.96 mean and 0.99 standard deviation. For statement number 2, students understood the discussions better with how the speaker communicates and relates to them, with a percentage of 42.9% and a mean of 4.11. Therefore, the critical points that the speaker highlighted and how the speaker delivered the content confidently allowed the students to be more engaged with the video discussion. Moreover, with a mean of 4.65, 69.2% strongly agreed that the speaker appeared to be knowledgeable of the content and passionate about teaching.

Table 11. Students' perception of the speaker's perspective and persona in the videos

Statements	Level of agreement (%)					Mean	SD	Interpretation
	1	2	3	4	5			
The video is more engaging because I feel like the speaker is talking to me directly.	3.8	3.8%	15.4	46.2	30.8	3.96	0.99	Agree
I can understand the discussion better because of how the speaker communicates and tries to relate with me.	3.8	0%	19.2	34.6	42.3	4.11	0.99	Agree
The speaker emphasizes key points that help retain my attention.	0	0%	7.7	46.2	46.2	4.38	0.63	Strongly agree
The speaker shows confidence and delivers the content concisely which makes me more engaged.	0	0%	19.2	30.8	50.0	4.30	0.78	Strongly agree
The speaker appears knowledgeable about his/her topic and exhibits passion for teaching.	0	0%	3.8	26.9	69.2	4.65	0.56	Strongly agree

Note. level of agreement: strongly disagree (1.00-1.80); disagree (1.81-2.60); neither agree nor disagree (2.61-3.40); agree (3.41-4.20); and strongly agree (4.21-5.00)

Supported by the study of Guo *et al.* [30] and Afify [31], the person narrating the video satisfies students' learning of simple and complex topics and thus makes the video more engaging. In addition, there is

a more intimate and personal interaction between the viewer and the speaker as information is communicated directly. Overall, the perspective and persona of the speaker matter greatly towards the deepening of understanding of the students, which positively affects their concept retention. Lastly, the length of the video matters most, especially to students with their attention span and interest at hand. It influences the students' decision to watch the video or not [15] and also the engagement or participation of the viewers [30].

The results from Table 12 suggest that 38.5% of the students agree and 26.9% strongly agree that the length maximizes their retention of the topic discussed. The second statement was also agreed by 34.6%, where length keeps them engaged throughout the IVs, underpinned by a mean of 3.80 and an SD of 1.09. However, both participants disagreed and disagreed that longer videos make them lose interest in learning and sticking through the discussion. However, 30.8% disagree with the statement, which slightly opposes the conclusion of Ali [15], that says students prefer short-length videos for longer videos to get them bored quickly.

Table 12. Participants' perception of the length of the videos used in the intervention

Statements	Level of Agreement					Mean	SD	Interpretation
	1	2	3	4	5			
The video length maximizes my retention towards the topic.	0%	11.5%	23.1%	38.5%	26.9%	3.89	0.98	Agree
The video length keeps me engaged throughout.	3.8%	3.8%	34.6%	23.1%	34.6%	3.80	1.09	Agree
The longer video makes me bored and loses my attention.	11.5%	30.8%	23.1%	23.1%	11.5%	2.92	1.23	Neither Agree nor Disagree
The longer videos are full of unimportant details.	42.3%	30.8%	23.1%	0%	3.8%	1.92	1.01	Disagree

Note. level of agreement: strongly disagree (1.00-1.80); disagree (1.81-2.60); neither agree nor disagree (2.61-3.40); agree (3.41-4.20); and strongly agree (4.21-5.00)

The video length should be taken with good observance other than the content, as students' attention span depends on their interest, which is affected by the video duration. The duration of the integrated videos was approximately 3-15 minutes. Thus, the students' attention span and interest are utilized; this is based on the statement of Guo *et al.* [30] that, at most, a 6-minute duration is the students' absolute engagement time. However, there was no video integration with more than a 20-minute duration of video discussion, so it might be one thing to consider for the subsequent study.

3.3. Learning experiences in using instructional videos

3.3.1. Positive experiences

IVs are widely used learning materials in education because of the factors that enable students to learn more than just the traditional ways of learning. The participants' learning experiences about using video materials positively responded to their learning process because it helped them engage with the topic more dynamically. Eight participants said that they enjoyed their learning process, and the video presentation made them learn easier and faster because the concepts or contents presented in the video helped them understand the topics better as shown in Table 13. The participants also said that the video's factors, such as their content, speaker, graphics and images, organization, and overall components, affect how they understand and learn the topic better. Another participant said that by having videos to re-watch any time of their convenience, they can learn at their own pace and review their understanding of the topics quickly.

> *"In my opinion the positive are the images and how it points out important words for each. I like images because I cannot see how they look and how the process works."* (Participant 3)
> *"The graphics and colors used caught my attention and the information said in the video was easy to remember."* (Participant 7)
> *"The IVs presented during science class were really entertaining because the speaker really explained well. The videos were also entertaining because it was not a dull looking video for me."* (Participant 2)
> *"I was able to learn at my own pace by watching the IVs."* (Participant 16)

Students who watched the videos took less time to acquire specific skills than those who did not. Using IVs is proven more convenient when learning [32]. IVs contribute to the students' learning progress in different subjects, especially in science. Studies from other researchers prove that videos are combined visual and verbal compositions that give students a complete package of learning experiences reflecting their

understanding of the concepts and retention of what they have learned throughout the experience [33], [34]. Therefore, all of the participants agreed that using IVs materials positively affects their learning experiences in the science subject.

Table 13. Themes and formulated meanings of students' learning experiences

Theme	Subthemes	Formulated meanings	f	Sources
Positive experiences	Emotional responses	Entertaining	2	P2, P11
		Fun	2	P11, P14
		Interesting	2	P14, P22
	Impact to learning	Makes learning easier and faster	3	P1, P10, P15
		Easy to catch up with the lesson	3	P5, P12, P15
		Learned more things and easy to remember	1	P8
		Learn effective and understand more	2	P11, P18
		Learning through own's pacing	1	P16
		Makes more focused in learning	1	P19
	Experience on IVs	Not dull	1	P2
		Contains main and important details	2	P2, P13
		Well prepared and organized	1	P4
		Understandable	2	P4, P9
		Graphics and colors capture attention	1	P7
		Information is easy to remember	2	P7, P8
	Others	No bad experiences overall	11	P1, P2, P5, P10, P13, P19, P20, P22, P23, P24, P26
Negative experiences	Impact to learning	Not able to jot down notes	3	P4, P6, P12
		Hard to understand sometimes	1	P22
		Boring	2	P7, P25
		Complicated terms	1	P11
		Speaker sometimes speaks too fast	2	P4, P14
	Technical difficulties	Lengthy	3	P4, P7, P18
		Low volume	1	P8
		Plays too fast	2	P9, P12
		Lagging/choppy connection	2	P15, P16

Note. P – Participant

3.3.2. Negative experiences

The learning experience is only complete with the opposing side or the other end if there is any. According to the 11 participants, they merely had negative or bad experiences from integrating videos during the discussion because it worked well. However, there were a few downsides that some participants mentioned as well, such as the type of video presented was lengthy, and they needed to be able to jot down important information because the speaker was talking so fast that they could not catch up; this shows that students prefer to watch short videos because their attention span depends on how long the video is and if it is entertaining them along the way.

> "*It is a bit lengthy which makes me lose interest. The speaker sometimes speaks too fast and I get confused. I take notes and it gets cut off because of it and also my brain cannot process the information right away."* (Participant 4)
> *"...not being able to take down notes because of the speed of how the graphics are shown since for me that really makes me understand a lot more about the topic."* (Participant 6)
> *"Sometimes there are things in the video that I am still confused about or there are complicated terms."* (Participant 11)
> *"The negative experience I had was that I could not catch up with the video because I was busy taking notes. Sometimes, it goes by too fast and I cannot remember."* (Participant 9)

Science IVs improve the appearance of contents, enhance text coherence, and provide tangible information. According to Kostereliogl [35], using IVs allows for a more effective learning environment, for it highly interests the students, helping them focus on the topic and refocusing them when their attention shifts. Therefore, the participants' negative experiences show that various factors affect their learning. For instance, the participants engage more in watching the video presentation when it is well-planned and organized. Information is put into simpler terms so they can remember and relate the key ideas they jot down on their notes. In lessons, IVs significantly impacted the student's learning experiences, improving concept retention, critical thinking, attention span, and note-taking. The suitability of the videos' features to the

students' capabilities should be considered, as negative feedback is inevitable in online learning. However, positive feedback outweighed the setbacks, led to open discussions, and improved concept retention.

4. CONCLUSION

This study sought to determine the factors of IVs that affect the student's concept retention in science. After conducting a thorough analysis and interpretation of the data gathered, the researchers conclude that there is a significant change between both the pre and post-tests of the experimental group (with IVs) and control group (without IVs). The conceptual understanding of the students in the topics reproductive system and nervous system as part of the learning competencies is noticeably positive. The test scores reveal that the students comprehend the lesson's key concept; therefore, the integrated IVs contributes to their retention of concepts. Between the median difference of experimental and control groups' retest and post-test results, it is concluded that there was no significant change observed. The researchers identified factors that affected students' level of concept retention, including the video content, speaker persona, motion graphics, video length, and language used in the videos and subtitles. Although students can increase their knowledge and skills with or without IVs, integrating IVs can facilitate a better understanding of lessons. The researchers noted that students may face challenges in the online learning environment, including unstable internet connection and distractions at home. The student's learning experiences are crucial in the learning process, and positive feedback was received on using IVs in the class. However, the researchers recommend integrating short and long videos in one class session and conducting the study in a face-to-face learning environment for a different approach. Lastly, due to limited time, the researchers predetermined factors that can affect students' retention, so it is suggested that participants identify different factors in a video for more exclusivity and undetermined choices.

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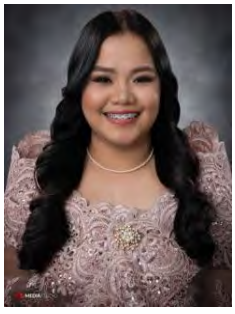

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